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Technical Report

Influence of alkali treatment and fibre length on mechanical properties of short Agave fibre reinforced epoxy composites

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ABSTRACT

Composites based on short Agave fibres (untreated and alkali treated) reinforced epoxy resin using three different fibre lengths (3 mm, 7 mm and 10 mm length) are prepared by using hand lay up and compression mould technique. The materials were characterized in terms of tensile, compressive, flexural, impact, water absorption properties and machinability behaviour. All mechanical tests showed that alkali treated fibre composites withstand more fracture strain than untreated fibre composites. As evidenced by the dynamic mechanical analysis (DMA) tests, the thermo-mechanical properties of the composite with alkali treated Agave fibre were considerably good as alkali treatment had facilitated more sites of fibre resin interface. The machinability and atomic force microscope (AFM) studies were carried out to analyze the fibre–matrix interaction in untreated and alkali treated Agave fibre–epoxy composites.

1. Introduction

The use of renewable resources such as plant and animal based fibre reinforced polymeric composites, has been becoming an important design criterion for designing and manufacturing components for all industrial products [1]. Problems related to the natural fibres such as inconsistency in the products performance due to basic nature of variability in the fibre origin, non availability in the moulding forms of reinforcements (roving, long fibre strands, and chopped strand mats, etc.), lead to the use of fibre in a partially prepared state [2]. Natural fibre composites are likely to be environmentally superior to glass fibre composites in most cases for natural fibre production has lower environmental impacts compared to glass fibre production [3]. The physical properties of natural fibres are mainly determined by the chemical and physical composition such as the structure of fibres, cellulose content and angle of fibrils, cross section, and by the degree of polymerization as reported by Bledzki and Gassan [4]. The development, characterization and optimization of flax fibre composites were performed to establish that the fibre structure and adhesion between the fibres and resin are essential to get better composites [5,6]. The effects of chemical modification, loading and orientation of short coir fibres and natural rubber composites [7], the degree of fibre matrix adhesion and its effect on the mechanical reinforcement of short henequen fibres and polyethylene matrix [8] and oil palm fibres reinforced phenol formaldehyde matrix composites [9] were analysed to show that the alkali/silane treatment significantly increased the mechanical strength. The influence of fibre length, fibre load and fibre orientation on the polypropylene/sisal composites were analysed by Joseph et al. [10] and 2 mm length fibre composites were found to give better results. The hydrophilic nature of natural fibres affects negatively its adhesion to hydrophobic polymer matrices [11]. Surface treated and untreated henequen fibres reinforced epoxy composites were made by compression moulding and their mechanical properties and failure modes were determined experimentally in tension, bending, and impact loading [12]. AFM adhesion force measurements on nature fibre samples are found to be highest on more polar samples such as steam alkaline and lowest on less polar samples such as acetylated and untreated fibres [13].

Thus the present study aims to develop short natural fibre composites from Agave (*Agave americana*), one of the most widely used natural fibers in yarns, ropes, twines, carpets, mats and handicrafts. Agaves are succulent plants of a large botanical genus of the same name, belonging to the family Agavaceae. This paper describes an investigation of the mechanical properties of short Agave fibre reinforced epoxy composites and the fibre length as a critical parameter for the properties of composites to establish its application in automotive bumper.

2. Materials and methods

2.1. Fibre preparation

Agave leaves, collected from the forest, where air dried for two days to remove excess moisture. Then retting of the leaves was

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